SHORT TERM SKELETAL RELAPSE AFTER ADVANCEMENT WITH BILATERAL SAGITTAL SPLIT RAMUS OSTEOTOMY: A RETROSPECTIVE STUDY

Dissertation submitted to
THE TAMILNADU DR. MGR MEDICAL UNIVERSITY

In partial fulfillment for the degree of
MASTER OF DENTAL SURGERY

BRANCH III
ORAL AND MAXILLOFACIAL SURGERY
APRIL 2011

CERTIFICATE

This is to certify that this dissertation titled **"SHORT TERM SKELETAL RELAPSE AFTER ADVANCEMENT WITH BILATERAL SAGITTAL SPLIT RAMUS OSTEOTOMY"** is a bonafide record of work done by **Dr. MUHAMMED RIYAS ALI** under our guidance and to our satisfaction during his postgraduate study period **2008-2011.**

This Dissertation is submitted to THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY, **in partial fulfillment for the award of the Degree of** MASTER OF DENTAL SURGERY– ORAL AND MAXILLOFACIAL SURGERY,BRANCH III. **It has not been submitted (partial or full) for the award of any other degree or diploma.**

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ACKNOWLEDGEMENT

I am greatly indebted to ***Dr. M.VEERABAHU,*** *Professor and Head of the Department, for his incessant support, invaluable teachings and a balance of encouragement and positive criticism at both personal and professional front throughout my training period. His unmatched quality of being a great surgeon and teacher and simultaneously possessing a calm wisdom and modest nature has always been a source of inspiration.*

I would like to extend my sincere gratitude to Professor ***Dr. S. RAMACHANDRAN****, Principal, for allowing us to use the scientific literature and other facilities of the college.*

I thank my Guide and Professor ***Dr. J. A. NATHAN*** *from the bottom of my heart for the inestimable guidance, unstinted support, constructive discussions and instilling a unique ability to present things in the best of way. Without his presence and supervision, my training and this dissertation would have been incomplete.*

I owe enormous debt of gratitude to my Professor ***Dr. MALINI JAYARAJ*** *for her valuable guidance and support* *throughout my course. Her loving and caring nature has lightened the burden of many hardships.*

I would also like to thank Professor ***Dr. B. VIKRAMAN****, for his precious advices, generous support and plentiful knowledge he has shared. I will always be benefitted from the distinctive quality imparted in us to look into problems from all three dimensions. His subtle humor and comments have been thoroughly enjoyed.*

I am greatly indebted to ***Dr. RADHIKA KRISHNAN,*** *Anesthesiologist,for her valuable suggestions and constant encouragement throughout my study.*

I would like to thank my Associate Professor. ***Dr. SRIPAL*** *for his valuable guidance and help.*

I would like to express my gratitude to ***Dr.EMMANUEL*** *for his help and support.*

I sincerely thank ***Dr. VENKAT*** *for his valuable support and guidance and his scholarly ideas and comments.*

I would also like to extend my gratitude to, ***Dr. SANKAR*** *who always has stood by all the postgraduates and provided them with valuable advices and guidance.*

I thank **Dr. MUTHUMANI,** who has been instrumental in my learning curve both as a senior colleague and later as a staff.

I would also like to thank **Dr. PRABHU,** for his valuable suggestions and guidance.

I would like to express my heartfelt and sincere gratitude to **Dr. VINESH. U ,** who has been a friend and an exceptional teacher at the same time.

I would like to extend my thanks to my friends and specially my batch mates **DR. ANUPAM. P, Dr. DANIEL. S, Dr. M. MANOJ , DR. G. SATHEESH** and **DR. S. SAKTHIVEL**

I would also like to extend my sincere gratitude to the **PARAMEDICAL** and **NON-TEACHING staff** of the institution for their support and help.

I would be doing injustice to my **PARENTS** and **FAMILY** if I don’t find words to thank them.

I pray to **THE ALMIGHTY,** who has always poured in his blessings and grace and mapped out every success path I have traversed in my life, to help me become a better person and surgeon and be able to justify the purpose of my existence.

INTRODUCTION

During the past thirty years, many significant advances have been made in the surgical correction of dentofacial malformations[27]. Combined orthodontic and surgical procedures are now commonly used to correct dentofacial malformations and provide improvement in oral function, facial aesthetics, psychological state and self image.

Orthognathic surgery is a surgical procedure to correct conditions of the jaw and face related to structure, growth, sleep apnoea, TMJ disorders or to correct orthodontic problems that cannot be easily treated with Orthodontic braces. Originally coined by Dr. Harold Hargis, D.M.D., It is also used in treatment of congenital conditions like cleft palate. Bones can be osteotomised and re-aligned, held in place with either screws or plates and screws[9,10].

Radiographs and photographs are taken to help in the planning and there is software to predict the shape of the patient's face after surgery, which is useful both for planning and for explaining the surgery to the patient and the patient's family. Advanced software can allow the patient to see the predicted results of the surgery.

The main goal of orthognathic surgery is to achieve an optimal occlusion, an aesthetic face and an enlarged airway. While correcting the bite is important, if the face is not considered the resulting bony changes might lead to an unaesthetic result. Orthognathic surgery is also available as a very successful treatment (90-100%) for obstructive sleep apnoea. Great care needs to be taken during the planning phase to maximize airway patency.

THE HISTORIC DEVELOPMENT OF ORTHOGNATHIC SURGERY

The historical development of orthognathic surgery has not been uniform and continuous but has rather followed a stepwise, intermittent course. The early-phase surgery was mainly limited to the mandible, while maxillary procedures were to come later. Orthognathic surgery was originally developed in the United States of America (Steinhauser 1996). The first mandibular osteotomy is considered to be Hullihen´s procedure in 1849 to correct a protrusive malposition of a mandibular alveolar segment caused by a burn (Hullihen 1849). Osteotomy of the mandibular body for the correction of prognathism was first carried out in 1897 as so called ´St Louis operation´. The osteotomy was performed by Vilray Blair, who later described several methods to correct maxillofacial deformities and was the first to present a classification of jaw deformities: mandibular prognathism, mandibular retrognathism, alveolar mandibular and maxillary protrusion and open bite[18]. He was also the first to underline the importance of orthodontics in the treatment. (Steinhauser 1996). The first phase of development in the USA came to an end at World War I (WW I), when surgeons had to concentrate on trauma surgery.

BILATERAL SAGITTAL SPLIT OSTEOTOMY:

1. **Definition:**

1) An intraoral surgical procedure for correction of retrognathism, apertognathia, and prognathism; the mandibular rami and posterior body are sectioned in the sagittal plane.

2) The mandibular sagittal split osteotomy surgery is done on the lower jaw (mandible) in order to move it anteriorly (in the case of a deficient lower jaw), or posteriorly (in the case of a enlarged lower jaw). It is performed posterior to the molars (not in the joint) and the jaw is sectioned in such a way that bony contact is always maintained. The bone is fixed in its new position by screws by mini plate screw fixation[11,27,28]. These heal with minimal external scarring. There are no gaps in the bone that have to be filled in, and it is not necessary to wire the teeth together during the postoperative healing period. Rigid fixation is now commonly used for the postoperative healing period, and this surgical technique eliminates the need to wire teeth together[10,13].

HISTORY OF BILATERAL SAGITTAL SPLIT OSTEOTOMY :

A surgical procedure resembling the Sagittal Split was described in 1942 in German literature by Schudart. However, Trauner and Obwegeser were the first to discuss its use in the English literature. In 1961, Dal Pont changed the lower horizontal cut to a vertical cut on the buccal cortex between the first and second molars, thereby obtaining broader contact surfaces and requiring minimal muscular displacement. In 1968, Hunsuck modified the technique, advocating a shorter, horizontal medial cut, just past the lingula, to minimize the soft tissue dissection. In 1977, Epker suggested several modifications. These modifications decreased the post operative swelling, haemorrhage and manipulation of neurovascular bundle.

Bell and Schendel established the biological basis for the BSSO, showing that with minimal detachment of pterygomassetric sling, intraosseous ischemia and necrosis of the proximal segment were significantly reduced. In 1976, Spiessel advocated rigid internal fixation of the BSSO to promote healing, restore early function and attenuate relapse[18].

THE ROLE OF ORTHODONTICS IN ORTHOGNATHIC SURGERY:

Orthodontics is an essential part of modern orthognathic surgery. This was stressed by the surgeon Converse and the orthodontist Horowitz in 1969. It is important that the dental arches are properly aligned before the operation. This makes accurate correction of the skeletal discrepancy possible, not only in the antero-posterior and transverse direction, but also vertically.

RECENT BACKGROUND / RESULT :

The sagittal split ramus osteotomy is a well-established procedure, and many authors have attempted various modifications of the surgical technique. Nowadays, it is widely acknowledged that people in Korea, Japan, and China prefer an oval face, the lower part of which is slender. Therefore, among facial contouring procedures, the mandible reduction procedure is the most popular procedure in many countries now most widely used. Despite technical refinements and widespread use, surgical advancement of mandible had not been uniformly successful. Invesitagors have shown consistently that the surgical changes are not entirely stable nor are the degree of stability or instability routinely predictable.

The various factors that which brings about relapse includes, muscular tension, alteration in condyle – articular fossa relationship during post operative period, inadequate fixation periods, methods of fixation, control of proximal segment during surgery, magnitude of distal segment advancement, unfavourable post surgical growth and surgeons level of experience. After mandibular orthognathic surgery the changes are seen at the condyle of the temporomandibular joint, and along the mandibular corpus and the ramus. In mandibular advancement surgery, a gradual decrease in the length of the mandibular body is seen due to resorptive process at the osteotomy site and a reduction of mandibular ramus length due to progressive condylar resorption. These changes are considered to relate to the skeletal relapse.

AIM AND OBJECTIVES

AIM:

The study is to analyze the short term skeletal relapse after mandibular orthognathic surgery and to determine its contributing factors in patients who have undergone orthognathic surgery with or without orthodontics.

OBJECTIVE:

The Objective of the study is to evaluate the rate of relapse after six months of mandibular advancement with bilateral sagittal split ramus osteotomy with the help of Burstone Hard tissue Analysis at five specific landmarks and to find the mean relapse rate at those landmarks respectively.

REVIEW OF LITERATURE

Hendricksen R et al (1982)[14] : Thirty-eight adult rhesus monkeys were used in the study of osseous remodelling of the gonial region following various types of experimental intervention. This study indicated the following: (1) When the length of the masseter muscle is increased by increasing the vertical dimension. (2) When the original length of the masseter muscle is increased by an appliance. (3) When a muscle is detached following an increase in vertical dimension and allowed to reattach spontaneously, the largest amount of gonial remodelling is observed. These observations indicate that both blood supply and function influence the shape of the gonial region.

Ellis E et al (1983)[7]: In this study Ten adult rhesus monkeys underwent mandibular advancement surgery of 4-6 mm with and without suprahyoid myotomy. Serial lateral cephalograms using radiopaque bone markers were obtained during maxillomandibular fixation and for 96 weeks after release of fixation to determine the effects of suprahyoid myotomy on short-term and long-term adaptations in the advanced mandible. The myotomy group exhibited no relapse during the fixation period and after release of fixation displayed a slight but statistically significant increase in mandibular length.

Jeter TS et al (1984)[18] **:** Conventional wire fixation of a sagittal split osteotomy of the mandible has been associated with more than 50 per cent relapses in some published and unpublished reports. Most such relapses occur during or shortly after the period of maxillomandibular fixation. Techniques to correct or accommodate such a relapse have included cervical collars, skeletal fixation, overcorrection, inferior border wires, posterior bite opening splints, and suprahyoid myotomies. The purpose of this article is to describe a modification of Spiessl's technique in which minimal skin incisions are used, and the need for screw removal is unlikely.

Will LA et al (1984)[37]**:** In this study Forty one patients who elected to receive a bilateral sagittal osteotomy to advance the mandible were examined clinically and radiographically to assess condylar position preoperatively and at three specific times postoperatively. No changes in condylar position were noted following release of fixation. suggests that maintenance of condylar position during surgery may not prevent temporomandibular joint dysfunction. In addition, the observed 37% relapse in surgical advancement in the absence of significant condylar distraction implies the interaction of other factors in the relapse process.

Aragon SB et al (1985)[1]: A prospective study of 55 orthognathic surgical patients was done to determine the effects of surgery on mandibular range of motion. A sagittal split osteotomy to advance the mandible was associated with the greatest mean reduction of 29%, while a vertical subcondylar osteotomy to set the mandible back had a mean reduction of 10%.

Lydiatt DD, Davis LF (1985**)**[23]**:** The effects of immobilization of joints covered with hyaline cartilage have been widely studied, the effects on the fibrous tissue covered temporomandibular joint have not been studied as extensively. This study was designed to determine the short-term effects of immobilization on the rabbit temporomandibular joint. They found a significant thinning was observed as early as after ten days, as was degeneration of the cartilage.

Van Nickels JE et al (1985)[32]: Nine subjects with horizontal mandibular deficiency treated by an BSSO and fixed with bone screws were prospectively studied. Serial cephalometric radiographs were traced and superimposed on the sella-nasion line and anterior cranial base structures. A markedly reduced horizontal movement during the first six weeks at both points B and Pg, followed by a slight advancement at six months, was observed.

Storum KA et al (1986)[30]**:** The efficacy of a systematic regimen of rehabilitation of mandibular function after ramus osteotomy was investigated. Forty-eight patients who had either sagittal split ramus osteotomy to advance the mandible or intraoral vertical ramus osteotomy to retract the mandible were studied; However, patients who underwent sagittal split ramus osteotomies without subsequent rehabilitation had significant decreases ($P < 0.05$) in mean mandibular opening and bite force as well as increases ($P < 0.05$) in muscular fatigability compared with patients who underwent rehabilitation.

Van Sickels JE et al (1986**)**[34] : The objectives of the present clinical investigation were to examine the effects in haemophiliacs of local antifibrinolytic treatment with tranexamic acid on the incidence of postoperative bleeding after oral surgery and on the amount of replacement therapy needed to control bleeding. The results of the study further suggest that replacement therapy can be reduced during oral surgery in the haemophilic patient provided that local and systemic inhibition of fibrinolysis is instituted.

Van Nickels JE et al (1986)[33]**:** In 19 subjects rigid fixation of bilateral sagittal split osteotomies was used for mandibular advancement. A multiple regression analysis with a backward stepping procedure was used to determine relationships between relapse, as defined by the position of pogonion at and B point during this same time interval. There were no other predictors of relapse. Advancements of 6 to 7 mm or greater as measured at B or Pg deserve special attention as they were more predisposed to relapse. Methods for preventing relapse are discussed.

Kempf K. K (1987)[19]: According to this study technique Following completion of the mandibular ramus sagittal split osteotomies, a thin, clear acrylic splint is ligated to the maxillary teeth or maxillary arch wire. The mandible is occluded into the splint and maxillomandibular wire fixation is applied. This technique has been used successfully by the author for the past year in over 30 patients.

Kirkpatrick TB et al (1987) [21] : According to this study, Twenty non-growing subjects underwent sagittal ramus osteotomies and rigid fixation. Cephalograms were analyzed before surgery, immediately after surgery and at least six months following surgery to evaluate skeletal stability. Resulting in a mean horizontal relapse of 0.42 mm (8%) and a mean vertical increase in lower face height of 0.2 mm were found six months after surgery.

Nishioka G J et al (1987)[26]**:** A study was conducted with twenty-one patients who underwent bilateral sagittal split osteotomies using rigid fixation were evaluated by neurosensory testing. Neurosensory tests included light touch (LT), brush stroke direction (BSD), two-point discrimination (2-P), and temperature (T). Tests were conducted using the two alternate forced choice method. The majority of demonstrable neurosensory disturbances were not dense. Increased age was associated with an increased incidence of neurosensory disturbance.

Van Merkesteyn JP et al (1987)[31] In this report, intra-operative complications in 124 sagittal split osteotomies and 34 vertical ramus osteotomies, carried out in 80 patients, are described. The incidence of intra-operative complications in the sagittal split osteotomies was 25.8%. The incidence of complications in the vertical ramus osteotomies was 11.8%.

Wolford et al (1987**)**[38]: Major advantages of this technique include controlled splitting of the segments and predictable positional control of the proximal segment. SURGlCAL PLANNING The surgical treatment objective and model surgery are completed in the usual manner. The advantages and disadvantages of rigid skeletal stabilization and discussed.

Ellis E (1988**)**[8]: This study examined the postsurgical range of mandibular motion following sagittal advancement osteotomy when either maxillomandibular or rigid osseous fixation were used. Seventeen adult female underwent sagittal advancement osteotomy of approximately 4 to 6 mm. Six had 6 weeks of maxillomandibular fixation and eleven had rigid osseous fixation with no maxillomandibular fixation. The results of this investigation showed that the animals who did not undergo maxillomandibular fixation maintained a greater range of motion in the early postsurgical period and obtained preoperative mobility by 12 weeks post surgery.

Rubens BC et al (1988)[27]**:** Skeletal stability was evaluated in 20 patients with mandibular hypoplasia, treated with bilateral sagittal split osteotomies to advance the mandible. Stable internal fixation was obtained using osseous miniplates and monocortical screws. Intermaxillary fixation was released after 5.15 days (range 1 to 11 days). Result of the study - Relapse measured at B-point was 10.7% and at Pogonion was 18.7%. Maximal opening decreased an average of 0.47 mm. Symptoms in 8 patients with TMJ dysfunction resolved, while 3 others developed TMJ dysfunction following surgery.

Ellis E et al (1989)[9] : Intra-oral, rigid, non-compressive fixation was used in a feasibility study in 10 consecutive sagittal split osteotomies using two 3.5 or 2.7 mm diameter AO screws on each side. Intermaxillary fixation (IMF) was necessary during the first 48 hours in one patient where the lingual fragments were too small. Intermaxillary elastics were used later in three patients. Mean horizontal relapse at 6 months (0.6 mm; maximum: 1.5 mm) was 8% of operative movement.

Hackney FL et al (1989)[13]: In this study changes in intercondylar width (ICW) and intercondylar angle (ICA) that occurred with rigid fixation after bilateral sagittal split osteotomy and mandibular advancement are documented and correlated with temporomandibular (TM) symptoms, magnitude of advancement, and mandibular shape. There was also no significant difference between the preoperative and postoperative incidence of TM pain or clicking. No correlation was found between the magnitude of advancement and the percent change.

Gassamann CJ et al (1990)[12]: The purpose of this study was to evaluate two different groups of patients who underwent bilateral sagittal split osteotomy for mandibular advancement. One group demonstrated no relapse, whereas a second group had documented relapse. With the help of questionnaire. 50 patients were included in the study. Repeated-measures showed that the majority of relapse occurred in the first 6 weeks after surgery.

Kerstens HC et al (1990)[20]**:** Radiographic evidence of condylar atrophy was seen in 12 patients out of 206 patients who underwent surgical orthodontic treatment. All 12 patients had the same dentofacial deformity, high-angle mandibular retrognathia (Class II open bite), and all but one had bimaxillary surgery. The dentofacial deformity is considered to be the main reason for condylar resorption, but orthognathic surgery is supposed to stimulate the progress of the disease by increased loading, disk displacement, and immobilization.

Boyd SB et al (1991)[3] **:** The aim of this prospective study was to define the patterns of recovery of mandibular mobility following three commonly performed orthognathic surgical procedures including BSSRO . A significant reduction in MM0 occurred immediately after surgery in the LE FORT and BSSRO groups and at release of fixation in the IVRO group.

Ellis E et al (1991**)**[10]: This study evaluated the histologic response of the temporomandibular joint (TMJ) following mandibular advancement using rigid and nonrigid fixation in monkeys. Animals who underwent MMF showed a tendency for anterior movement of the condyles; animals who underwent rigid fixation showed a tendency for posterior condylar position. Thicker cartilage layers were found in the MMF animals.

Moore KE et al (1991)[25]**:** This reports Five cases showing a typical relapse pattern are presented, illustrating the role of condylar resorption. The findings, in addition to reports in the literature, suggest condylar resorption following mandibular advancement has a multifactorial origin. Its role in the development of skeletal relapse may be more significant than previously implicated.

Shepherd JP et al (1991)[29]**:** In this study Intra-oral, rigid, non-compressive fixation was used in a feasibility study in 10 consecutive sagittal split osteotomies using two 3.5 or 2.7 mm diameter AO screws on each side. Seven patients were prognathic, three were retrognathic, and two had severe mandibular asymmetry. Mean horizontal relapse at 6 months (0.6 mm; maximum: 1.5 mm) was 8% of operative movement. Unsatisfactory occlusion (anterior open bite) necessitated removal of screws at 28 days in one patient. This was carried out intra-orally under local anaesthesia. These results suggest that stable, screw fixation for sagittal split osteotomies can be achieved without recourse to an external approach.

Lee J. Piecuch JF (1992)[22]**:** Radiographs of 15 patients who underwent sagittal split mandibular ramus osteotomy with rigid miniplate fixation for mandibular lengthening were studied. Evaluation of postoperative stability of the mandibular lengthening at 6 months to 2 years revealed minimal postoperative changes. These postsurgical skeletal changes at point B and at pogonion average out to mean changes of 1.5% find 1.4%, respectively

De Bont LGM et al (1993)[6]: Temporomandibular joint (TMJ) osteoarthrosis and disk displacement seem to be strongly related, but they may also represent mutually independent temporomandibular disorders. This paper presents relevant aspects of normal physiology and degeneration of synovial joints, aspects of normal temporomandibular articular disk physiology and of displacement of the disk, the relationship between TMJ osteoarthrosis and disk displacement, and a general classification of temporomandibular disorders.

Bouwman JP et al (1994)[2] According to this study, Condylar resorption that occurs after orthognathic surgery was investigated in a large sample of patients treated in the Department of Oral and Maxillofacial Surgery of the Free University in Amsterdam, the Netherlands. The findings correspond with previous publications on this subject. In a l-year follow-up study the role of intermaxillary fixation was investigated radiologically. In a group of 158 patients prone to show occurrence of condylar resorption, 24 (264%) of the 91 patients treated with intermaxillary fixation showed signs of condylar resorption. In the group of 67 patients treated without intermaxillary fixation only eight (11.9%) of the patients showed signs of reduced volume of the condyle.

Caawfolto JG et al (1994)[4]: According to the study Seven cases of progressive condylar resorption after orthognathic surgery are presented, their subsequent treatment is described, and the results are analyzed.

Scheerlinck JP et al (1994)[28] Skeletal stability, temporomandibular joint (TMJ)-function, and inferior alveolar nerve function were evaluated in 103 patients with mandibular hypoplasia who were treated with bilateral sagittal split osteotomies to advance the mandible. Stable internal fixation was obtained with miniplates. Sixty-eight percent of the patients with preoperative TMJ-dysfunction symptoms. Sixteen percent experienced worsening of their TMJ symptoms.

Feinerman DM et al (1995**)**[11]: In this study conducted, Sixty-six patients were examined between 2 and 9.5 years after bilateral sagittal split mandibular ramus osteotomy. Thirty-two patients had nonrigid fixation consisting of superior border wires and intermaxillary fixation, while 34 patients had rigid plate fixation of the osteotomy sites with immediate function. There were no demonstrable long-term differences between the two groups with respect to mandibular vertical opening, crepitance, and temporomandibular joint pain.

Hoppenretls TJM et al (1997)[16]: A sample of 267 patients with maxillary hyperplasia, a Class I or Class II/I occlusion and anterior vertical open bites, collected from three different institutions, was analysed regarding stability after surgical corrections. Cephalometric radiographs were collected before orthodontic treatment, before surgery, immediately after surgery, one year postoperatively and at the latest follow up. The mean follow up was 69 months (range 20-210 months). It can be concluded that patients with anterior open bites, treated with a Le Fort I osteotomy in one-piece or in multi-segments, with or without bilateral sagittal split osteotomy, exhibited good skeletal stability of the maxilla. Rigid internal fixation produced the best maxillary and mandibular stability.

Cutbirth M et al (1998)[5] evaluated long-term condylar resorption after mandibular advancements stabilized with bicortical screws. The study concludes that the patients with large advancements and preoperative temporomandibular joint symptoms appear to be at risk for condylar resorption.

Hoppenreijs TJ et al (1998)[15] study included A sample of 259 patients with vertical maxillary hyperplasia, mandibular hypoplasia and anterior vertical open bite, and condylar resorption collected from three different institutions, was analysed. All patients underwent Le Fort I osteotomies, and bilateral sagittal split advancement osteotomies were performed in 117 patients. Intraosseous wire fixation was used in 149 and rigid internal fixation in 110 patients. Rigid internal fixation in bimaxillary osteotomies resulted in condylar remodelling in 30% and progressive condylar resorption in 19% of the patients.

Van Sickels JE et al (1999)[36]: In this randomized clinical study, two groups of patients who underwent a bilateral sagittal split osteotomy and either wire osteosynthesis or rigid fixation were compared. Cephalometric radiographs obtained before surgery, immediately after surgery, and at 8 weeks, 6 months, and 1 and 2 years after surgery were available for 125 of these patients, 63 with wire fixation and 62 with rigid fixation. Whether wire osteosynthesis or rigid fixation was used, the ultimate condylar position was posterior and superior after a bilateral sagittal split osteotomy to advance the mandible.

Hwang SJ et al (2000)[17]**:** The purpose of this study was to look for surgical risk factors for condylar resorption after orthognathic surgery. Seventeen patients of a group of 452 patients who had undergone orthognathic surgery consecutively and who were in accordance with the inclusion criteria of this study showed postoperative condylar resorption. This controlled study concluded that counterclockwise rotation of the distal and proximal mandibular segments and surgically induced posterior condylar displacement seem to be important surgical risk factors for postoperative condylar resorption. Therefore, these movements seem to be contraindicated in patients who are at high risk.

MATERIALS AND METHODS

Thirty five consecutive patients were treated for skeletal Class II malocclusion during the period between 1999 and 2008. They all had either underwent skeletal orthognathic surgical procedure or combined orthodontic and surgical treatment with BSSRO advancement and rigid fixation along with other combined surgery. Of these, nine patients (26%) were available for a long-term cephalography in 2010. The measurement was performed based on the serial cephalograms taken preoperatively; ranging from - 1 week, 1 month, 6 months, postoperatively; and at the final evaluation after an average of 11 years. Mean mandibular advancement done for these patients was 5.67mm.

SELECTION OF CASES:

Patients who has taken treatment for skeletal orthognathic problems in The Dept of Oral and Maxillofacial Surgery, Ragas Dental College and Hospital, Chennai.

INCLUSION CRITERIA:

Patients who have undergone treatment for mandibular deficieny. (Bilateral sagittal split ramus osteotomy).

EXCLUSION CRITERIA;

Patients of age group below 15 years were exempted from the the study. Immunocompromised patients and patients with bony pathologies were excluded from the study.

MATERIALS:

1) Cephalograms
2) Acetate tracing sheets
3) X- ray viewer
4) Tracing pencils
5) Geometrical instrument box
6) Measuring tape/Scale

METHOD:

- A series of lateral cephalogram radiograph for all cases is done Consecutive patients had combined orthodontic and surgical treatment for skeletal Class II malocclusion between 1999 and 2010 in The Dept of Oral and Maxillofacial Surgery, Ragas Dental College and Hospital.

Of these thirty five patients 26% were available for a long-term cephalography in 2010.

The mean time between the primary orthognathic surgery and the final cephalometric examination was 11 years (range 1-11 years).

There were 7 women and 2 men with the mean age of 23 years (range 17– 28 years)

LandMarks Required for the Lateral cephalogram tracing

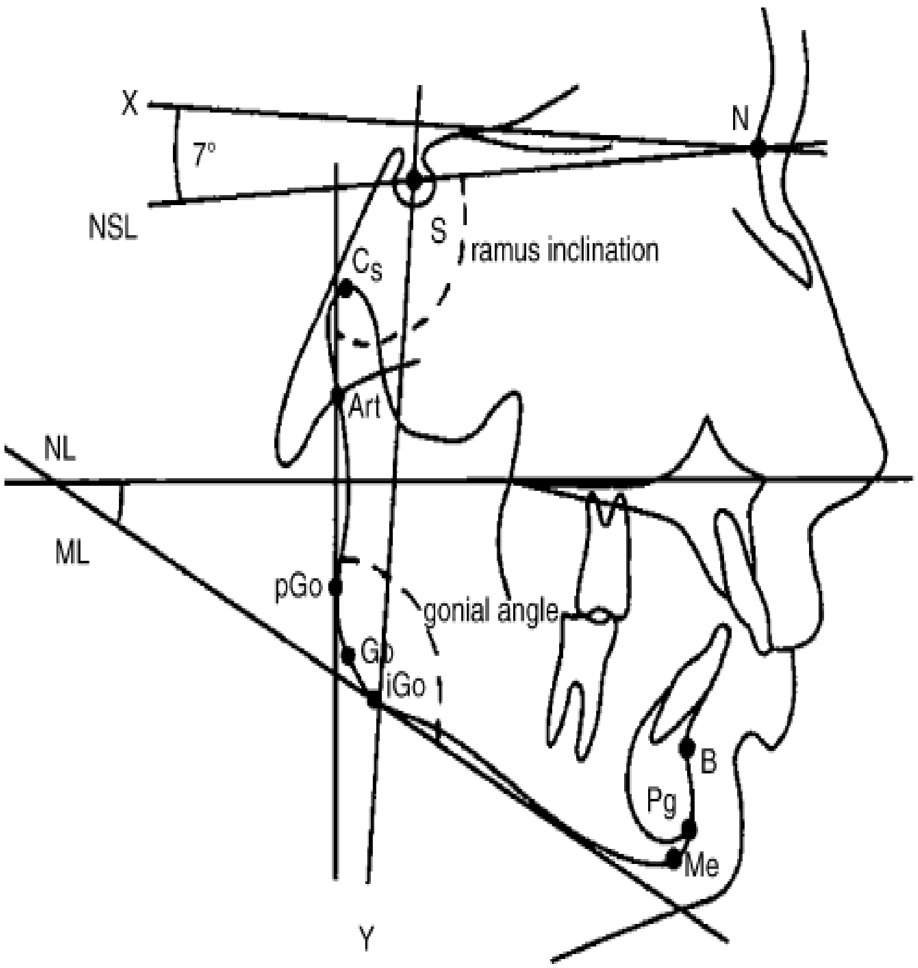
1) N - Nasion: the most anterior point of fronto nasal suture
2) S - Sella: the center of sella turcsica

3) B-point: deepest point on the contour of mandible between incisor tooth and bony chin
4) Pg - Pogonion: most anterior point on osseous contour of chin
5) Me - Menton: most inferior midline point on mandibular symphysis
6) Go - Gonion: a point on the curvature of the angle of the mandible made by the tangent to the posterior ramus and inferior border of the mandible

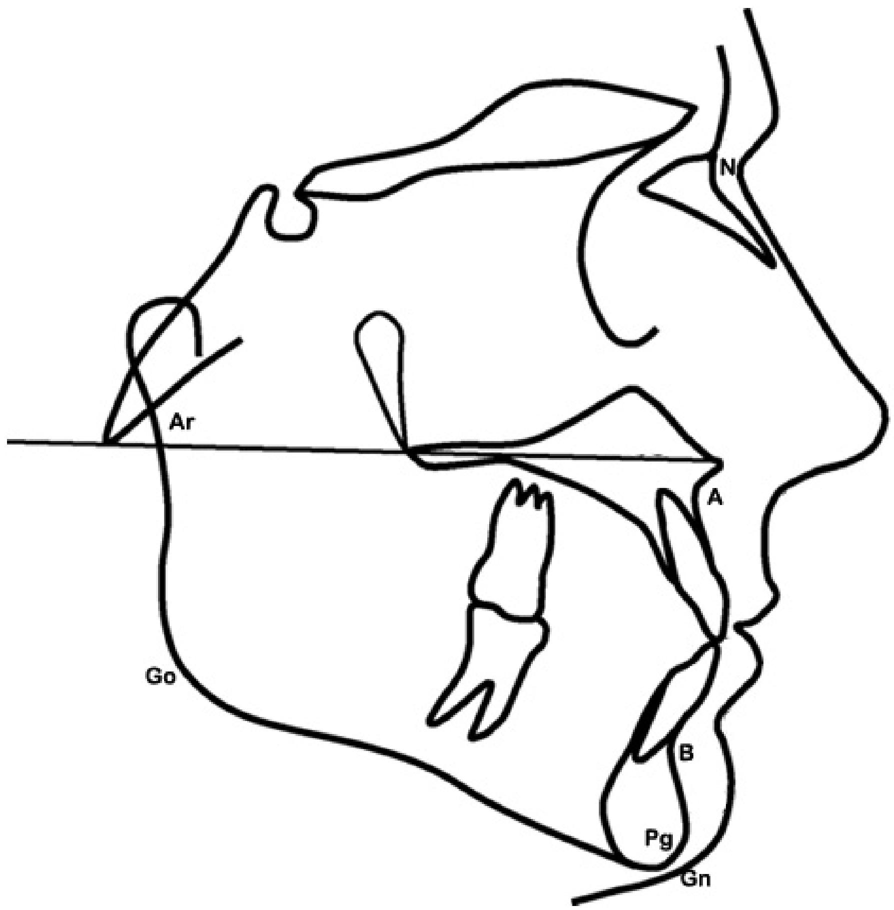
The study is done based on Burstone Hard tissue Cephalometric analysis. The five relevant points taken from the Burstone analysis are:

1. N-A-Pg angle
2. N-B
3. N-Pg
4. Go-Pg (Linear)
5. Ar-Go-Gn angle

Cephalometric landmarks for lateral projection



. Hard and soft tissue landmarks used in cephalometric analysis.



Burstone Hard tissue LandMarks used in the Study

PROFORMA

OP.NO BLOOD GROUP:

NAME AGE/SEX

ADDRESS:

OCCUPATION:

PRESENTING COMPLAINT:

MOTIVATION:

INTERNAL

EXTERNAL

PAST MEDICAL HISTORY:

CVS

ENDOCRINE

RS

GIT

HAEMORRHAGIC DISORDER

CNS

MISCELLANEOUS

DRUG ALLERGY:

FAMILY HISTORY:

AGE OF MENARCHE:

GENERAL EXAMINATION:

HEIGHT

GROWTH STATUS

WEIGHT

ANAEMIA

CYANOSIS

PULSE

B. P

EXAMINATION OF HEAD, FACE AND NECK:

POSITION OF HEAD

FLEXED

PROTRUDED

STRAIGHT

SYMMETRY OF FACE

INTERCANTHAL DISTANCE

FACIAL PROPORTIONS:

UPPER ONE THIRD:

A. CRANIUM

B. SUPRAORBITA

MIDDLE ONE THIRD:

A. ORBIT AND EYES

B. MALAR REGION

C. NOSE

SEPTAL DEVIATION

ALAR BASE WIDTH

NASAL BASE WIDTH

NASAL BASE HEIGHT

INNER ALAR DISTANCE

LOWER ONE THIRD:

UPPER LIP

LENGTH

VERMILLION EXPOSURE

INCISOR EXPOSURE AT REST

INCISOR EXPOSURE AT SMILE

PROTRUSION OF LIP

TONE

THICKNESS

MAXILARY MIDLINE TO MID

SAGITTAL PLANE

INTERLABIAL DISTANCE

LOWER LIP

VERMILION EXPOSURE

TONE

THICKNESS

LABIO MENTAL SULCUS

CHIN (PROMINENCE, SYMMETRY)

‘E’ LINE

NASOLABIAL ANGLE

TMJ EXAMINATION

NECK MOVEMENT

AIRWAY ASSESSMENT

INTRAORAL EXAMINATION

MAXIMUM MOUTH OPENING

MANDIBULAR DEVIATION

OCCLUSION

OCCLUSAL CANT

CURVE OF SPEE

CROWDING

ARCH RELATION SHIP

TONGUE:

SIZE

POSTURE

FRENULA

FUNCTION

OCCLUSION:

OVERJET

OVERBITE

SOFT TISSUE ABNORMALITY

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
Burstone Analysis (Hard Tissue)

LANDMARKS	FEMALE	PATIENT'S VALUE	INFERENCE (PROBLEM LIST)
CRANIAL BASE: SN length=			
Ar – Ptm (II) HP	32.8 ± 1.9 (30.9 to 34.7)		
Ptm - N (II) HP	50.9 ± 3.0 (47.9 to 53.9)		
HORIZONTAL			
N – A – Pg (Angle)	$2.6^0 \pm 5.1^0$ (-2.5^0 to 7.7^0)		
N – A (II HP)	-2 ±3.7 (-5.7 to 1.7)		
N – B (II HP)	-6.9 ±4.3 (-11.2 to -2.6)		
N – Pg (II HP)	-6.5 ± 5.1 (-11.6 to 1.4)		
VERTICAL (SKELETAL)			
N – ANS (⊥ HP)	50 ± 2.4 (47.6 to 52.4)		
ANS – Gn (⊥ HP)	61.3 ± 3.3 (58 to 64.6)		
PNS – N (⊥ HP)	50.6 ±2.2 (48.4 to 52.8)		
MP – HP (Angle)	$24.2^0 \pm 5^0$ (19.2^0 to 29.2^0)		
VERTICAL (DENTAL)			
1┘ - NF (⊥ NF)	27.5 ± 1.7 (25.8 to 29.2)		
1┐ - MP (⊥ MP)	40.8 ± 1.8 (39 to 42.6)		
6┘ - NF (⊥ NF)	23.0 ± 1.3 (21.7 to 24.3)		
6┐ - MP (⊥ MP)	32.1 ± 1.9 (30.2 to 34)		
MAXILLA – MANDIBLE			
PNS – ANS (II HP)	52.6 ±3.5 (49.1 to 56.1)		
Ar – GO (Linear)	46.8 ± 2.5 (44.3 to 49.3)		
Go – Pg (Linear)	74.3 ± 5.8 (68.5 to 80.1)		
B – Pg (II MP)	7.2 ± 1.9 (5.3 to 9.1)		
Ar – Go – Gn (Angle)	$122^0 \pm 6.9^0$ (115.1^0 to 128.9^0)		
DENTAL			
OP – HP (Angle)	$7.1^0 \pm 2.5^0$ (4.6^0 to 9.6^0)		
A – B (II OP)	-0.4 ±2.5 (-2.9 to 2.1)		
1┘ - NF (Angle)	$112.5^0 \pm 5.3^0$ (107.2^0 to 117.8^0)		
1┐ . MP (Angle)	$95.9^0 \pm 5.7^0$ (90.2^0 to 101.6^0)		

Name: Age / Sex: Reg. No:

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
Burstone Analysis (Hard Tissue)

LANDMARKS	MALE	PATIENT'S VALUE	INFERENCE (PROBLEM LIST)
CRANIAL BASE: S-N length=			
Ar – Ptm (II) HP	37.1 ± 2.8 (34.3 to 39.9)		
Ptm - N (II) HP	52.8 ± 4.1 (48.7 to 56.9)		
HORIZONTAL			
N – A – Pg (Angle)	3.9^0 ± 6.4^0 (-2.5^0 to 10.3^0)		
N – A (II HP)	0.0 ±3.7 (3.7 to -3.7)		
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)		
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)		
VERTICAL (SKELETAL)			
N – ANS (⊥ HP)	54.7±3.2 (51.5 to 57.9)		
ANS – Gn (⊥ HP)	68.6 ± 3.8 (64.8 to 72.4)		
PNS – N (⊥ HP)	53.9 ±1.7 (52.2 to 55.6)		
MP – HP (Angle)	23^0 ± 5.9^0 (17.1^0 to 28.9^0)		
VERTICAL (DENTAL)			
1┘ - NF (⊥NF)	30.5 ± 2.1 (28.4 to 32.6)		
1┐ - MP (⊥ MP)	45.0 ± 2.1 (42.9 to 47.1)		
6┘ - NF (⊥ NF)	26.2 ± 2.0 (24.2 to 28.2)		
6┐ - MP (⊥ MP)	35.8 ±2.6 (33.2 to 38.4)		
MAXILLA – MANDIBLE			
PNS – ANS (II HP)	57.7 ±2.5 (55.2 to 60.3)		
Ar – GO (Linear)	52.0 ±4.2 (47.8 to 56.2)		
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)		
B – Pg (II MP)	8.9 ± 1.7 (7.2 to 10.6)		
Ar – Go – Gn (Angle)	119.1^0± 6.5^0 (112.6^0 to 125.6^0)		
DENTAL			
OP – HP (Angle)	6.2^0 ± 5.1^0 (1.1^0 to11.3^0)		
A – B (II OP)	-1.1 ±2.0 (-3.1 to 0.9)		
1┘ - NF (Angle)	111.0^0 ±4.7^0 (106.3^0 to 115.7^0)		
1┐ - MP (Angle)	95.9^0 ± 5.2^0 (90.7^0 to 101.1^0)		

Name: Age / Sex: Reg. No:

<u>**CASE 1**</u>

PICTURES:

<u>**PRE – OP LATERAL CEPH**</u>

IMMEDIATE POST OP LATERAL CEPH

6 MONTHS POST OP LATERAL CEPH

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
Burstone Analysis (Hard Tissue)

PRE - OP (01-10-98)

LANDMARKS	MALE	PATIENT'S VALUE
N – A – Pg (Angle)	$3.9^0 \pm 6.4^0$ (-2.5^0 to 10.3^0)	17^0
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)	-25 mm
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)	-27mm
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)	85 mm
Ar – Go – Gn (Angle)	$119.1^0 \pm 6.5^0$ (112.6^0 to 125.6^0)	125^0

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
IMMEDIATE POST OP (23-12-00)

N – A – Pg (Angle)	$3.9^0 \pm 6.4^0$ (-2.5^0 to 10.3^0)	12^0
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)	-06 mm
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)	-03mm
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)	94 mm
Ar – Go – Gn (Angle)	$119.1^0 \pm 6.5^0$ (112.6^0 to 125.6^0)	132^0

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
6 MONTHS POST OP (09-05-01)

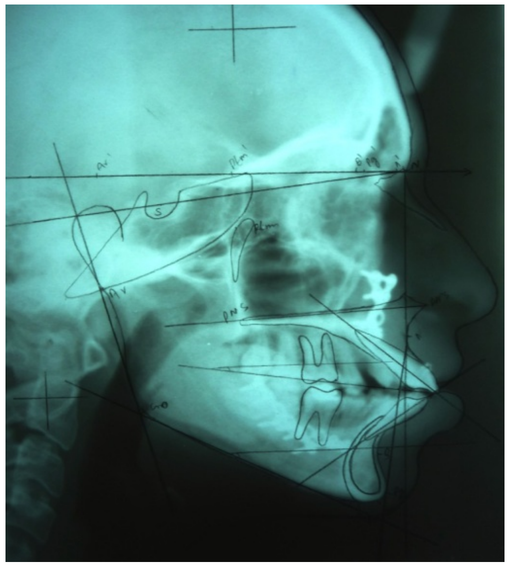
LANDMARKS	MALE	PATIENT'S VALUE
N – A – Pg (Angle)	$3.9^0 \pm 6.4^0$ (-2.5^0 to 10.3^0)	08^0
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)	-06 mm
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)	-06mm
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)	94 mm
Ar – Go – Gn (Angle)	$119.1^0 \pm 6.5^0$ (112.6^0 to 125.6^0)	132^{0}

CASE 2

PICTURES:

PRE – OP LATERAL CEPH

IMMEDIATE POST OP LATERAL CEPH



6 MONTHS POST OP LATERAL CEPH

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
Burstone Analysis (Hard Tissue)

PRE - OP (03-06-05)

LANDMARKS	FEMALE	PATIENT'S VALUE
N – A – Pg (Angle)	$2.6^0 \pm 5.1^0$ (-2.5^0 to 7.7^0)	12°
N – B (II HP)	-6.9 ±4.3 (-11.2 to -2.6)	-18 mm
N – Pg (II HP)	-6.5 ± 5.1 (-11.6 to 1.4)	-13 mm
Go – Pg (Linear)	74.3 ± 5.8 (68.5 to 80.1)	83 mm
Ar – Go – Gn (Angle)	$122^0 \pm 6.9^0$ (115.1^0 to 128.9^0)	123 °

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
IMMEDIATE POST OP (20-07-05)

LANDMARKS	FEMALE	PATIENT'S VALUE
N – A – Pg (Angle)	$2.6^0 \pm 5.1^0$ (-2.5^0 to 7.7^0)	09°
N – B (II HP)	-6.9 ±4.3 (-11.2 to -2.6)	-12 mm
N – Pg (II HP)	-6.5 ± 5.1 (-11.6 to 1.4)	-09 mm
Go – Pg (Linear)	74.3 ± 5.8 (68.5 to 80.1)	85 mm
Ar – Go – Gn (Angle)	$122^0 \pm 6.9^0$ (115.1^0 to 128.9^0)	134 °

ORTHOGNATHIC CEPHALOMETRIC EVALUATION

6 MONTHS POST OP (20-02-06)

LANDMARKS	FEMALE	PATIENT'S VALUE
N – A – Pg (Angle)	$2.6^0 \pm 5.1^0$ (-2.5^0 to 7.7^0)	07°
N – B (II HP)	-6.9 ±4.3 (-11.2 to -2.6)	-10 mm
N – Pg (II HP)	-6.5 ± 5.1 (-11.6 to 1.4)	-09 mm
Go – Pg (Linear)	74.3 ± 5.8 (68.5 to 80.1)	81 mm
Ar – Go – Gn (Angle)	$122^0 \pm 6.9^0$ (115.1^0 to 128.9^0)	133 °

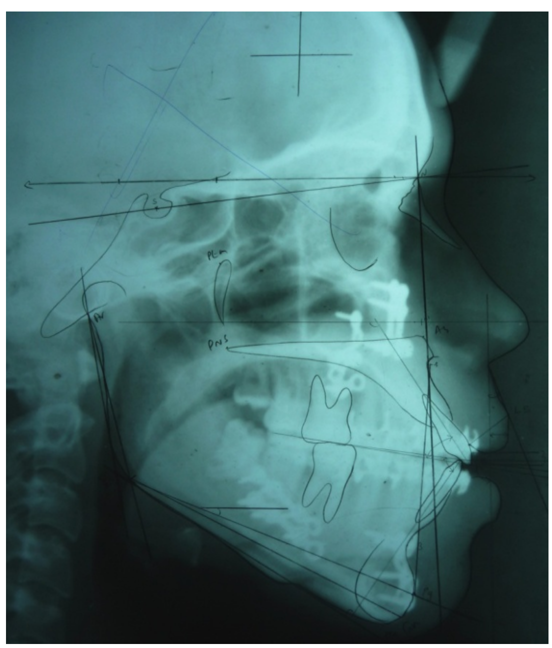
CASE 3

PICTURES:

PRE – OP LATERAL CEPH

IMMEDIATE POST OP LATERAL CEPH

6 MONTHS POST OP LATERAL CEPH



ORTHOGNATHIC CEPHALOMETRIC EVALUATION
Burstone Analysis (Hard Tissue)

PRE - OP (09-05-05)

LANDMARKS	MALE	PATIENT'S VALUE
N – A – Pg (Angle)	$3.9^0 \pm 6.4^0$ (-2.5^0 to 10.3^0)	17^0
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)	-3 mm
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)	-05mm
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)	75 mm
Ar – Go – Gn (Angle)	$119.1^0 \pm 6.5^0$ (112.6^0 to 125.6^0)	130^0

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
IMMEDIATE POST OP (05-09-05)

LANDMARKS	MALE	PATIENT'S VALUE
N – A – Pg (Angle)	$3.9^0 \pm 6.4^0$ (-2.5^0 to 10.3^0)	14^0
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)	+03 mm
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)	+02 mm
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)	87 mm
Ar – Go – Gn (Angle)	$119.1^0 \pm 6.5^0$ (112.6^0 to 125.6^0)	134^0

ORTHOGNATHIC CEPHALOMETRIC EVALUATION
6 months Post Op (06-02-06)

LANDMARKS	MALE	PATIENT'S VALUE
N – A – Pg (Angle)	$3.9^0 \pm 6.4^0$ (-2.5^0 to 10.3^0)	10^0
N – B (II HP)	-5.3 ±6.7 (-12 to 1.4)	+02 mm
N – Pg (II HP)	-4.3 ± 8.5 (-12.8 to 4.2)	+02 mm
Go – Pg (Linear)	83.7 ± 4.6 (79.1 to 88.3)	85 mm
Ar – Go – Gn (Angle)	$119.1^0 \pm 6.5^0$ (112.6^0 to 125.6^0)	$133\ ^0$

RESULTS

This is a retrospective, randomized study. Based on selection criteria, nine patients, two males and seven females were selected. The ages ranged from 17-28. The follow up period was six months, ranging from immediate post op days to six months.

A minimum advancement of 5mm and maximum advancement of 07mm is done . In all the nine cases mandibular advancement is done in the horizontal plane. The mean mandibular advancement was 5.67mm.

In the Horizontal plane the N-A-Pg angle, N-B-point, N-Pg point, Go-Pg (Linear) point and Ar-Go-Gn Angle were calculated. Anterior movement of B-point was accompanied by a significant increase.

Out of the nine patients who were included in the study, six patients underwent BSSRO advancement surgery along with other maxillary osteotomies (Lefort 1 Osteotomy and Anterior Maxillary Osteotomy). Three patients underwent BSSRO advancement surgery with orthodontic treatment inorder to achieve ideal aesthetic, functional and dental harmony (Table 1).

N-A-Pg angle:

Two of the nine patients showed a relapse of 4° which is the maximum and three patients showed no relapse. The mean relapse at this point is 1.56° with a S.D of 1.589 (Table 2).

N-A-Pg angle represents the degree of skeletal convexity. The angle gives an indication of overall facial convexity. It is an angle formed by the line N-A and A-Pg.

The +veAngle (clockwise) infers convex face and –ve angle (counterclockwise) infers concave face.

The facial convexity after BSSRO advancement remained unchanged for three patients. All these three patients are in the same age group (23-24 yrs) old. Mild convexity change is seen in four patients which can be as a result of various factors including age and growth.

N-B

One of nine patients showed a relapse of 4mm which is the maximum and four patients showed no relapse. The mean relapse at this point is 1.11 mm with a S.D of 1.364 (Table 3).

This landmark is used for planning anterior mandibular horizontal advancement and reduction. This landmark quantitates the anteroposterior position of mandible and degree of mandibular horizontal dysplasia.

The position denoting the deepest concavity in the chin shows very minimal relapse after the six months of the advancement surgery. One patient showed a significant relapse of 4mm. The growth factor and the muscle pull attributes to the relapse.

N-Pg :

Out of the nine patients, one patient showed a relapse of 4mm which is the maximum and four patients showed no relapse. The mean relapse at this point is 1.11 mm with a S.D of 1.589 (Table 4).

This landmark represents the chin prominence which is very useful in determining whether there is a horizontal genial hyperplasia/hypoplasia.

Chin prominence is unchanged in four patients of the nine patients. A 17 year old female showed a significant relapse at the chin. The age and growth factor played an important role in the relapse.

Go-Pg (Linear):

Out of the nine patients, one patient showed a relapse of 6mm which is the maximum and one patient showed no relapse. The mean relapse at this point is 2.33 mm with a S.D of 1.802 (Table 5).

Go-Pg establishes the length of the mandibular body. It is constructed by a line from Go to Pg. It is a very useful landmark in assessing the increased/decreased mandibular body length.

The Corpus length of the mandible showed a relapse ranging from from 1mm to 6 mm. The greatest relapse in size of the mandibular Corpus length is seen in one female patient, which is attributed by the growth factor of the mandible.

Ar-Go-Gn Angle:

The Gonial angle shows the least relapse with a maximum of 02° in a female patient. One of nine patients showed a relapse of 2° which is the maximum and one patient showed no relapse. The mean relapse at this point is 1° with a S.D of 0.5 (Table 6).

This angle represents the relationship between the ramal plane and mandibular plane. It constructed by a line drawn from Ar to Go and another line from Go-Gn.

This landmark is helpful in contributing the diagnosis of skeletal open/closed bite problems (acute/obtuse angle).

The Gonial angle does not shows any significant changes except in one female patient with a maximum of 2° which can be as a result of micromovements followed by the fixation.

Data from the nine patients included in the study suggests the following.

N-A-Pg angle shows a mean relapse of 1.56 ± 1.589, N-B (1.11mm ± 1.36), N-Pg (1.56mm ± 1.589), Go-Pg (2.33 mm ± 1.802), Ar-Go-Gn (1± 0.5)

The advancement done at these four points and the relapse calculated are tabulated in the tables (Table 2,3,4,5,6) :

The surgical advancement at the 5 landmarks with the skeletal relapse after six months with the pre operative and post operative data is mentioned in the table 7.

The mean horizontal advancement and relapse at the 5 landmarks are projected in Chart – I.

THE TYPE AND COMBINATION OF THE SURGICAL TREATMENT ALONG WITH BSSRO ADVANCEMENT SURGERY IS TABULATED IN THE COLUMN BELOW

Table 1

BSSRO ADVANCEMENT + MAXILLARY OSTEOTOMY + ORTHODONTIC TREATMENT	0
BSSRO ADVANCEMENT + MAXILLARY OSTEOTOMY	6
BSSRO ADVANCEMENT ONLY	0
BSSRO ADVANCEMENT + ORTHODONTIC TREATMENT	3

Table 2

Patient	N-A-Pg Angle			
	Pre Op	**Immediate Post Op**	**6 Months Post Op**	**Difference**
CASE1 28/M	17°	08°	12°	04°
CASE 2 22/F	12°	07°	09°	02°
CASE 3 24/M	24°	10°	14°	04°
CASE 4 23/F	15°	15°	15°	00°
CASE 5 24/F	12°	12°	12°	00°
CASE 6 17/F	30°	18°	20°	02°
CASE 7 19/F	23°	16°	17°	01°
CASE 8 17/F	40°	19°	20°	01°
CASE 9 23/F	06°	04°	04°	00°
MEAN				1.56°
MEAN ± S.D				1.56° ± 1.589

Table 3

Patient	N-B			
	Pre Op	**Immediate PostOp**	**6 Months Post Op**	**Difference**
CASE1 28/M	-25mm	-06mm	-06mm	00mm
CASE 2 22/F	-18mm	-10mm	-12mm	02mm
CASE 3 24/M	-03mm	+03mm	+02mm	01mm
CASE 4 23/F	-08mm	+02mm	+01mm	01mm
CASE 5 24/F	-21mm	+19mm	+17mm	02mm
CASE 6 17/F	-20mm	-10mm	-10mm	00mm
CASE 7 19/F	-14mm	-06mm	-10mm	04mm
CASE 8 17/F	-11mm	-04mm	-04mm	00mm
CASE 9 23/F	-13mm	-09mm	-09mm	00mm
MEAN				1.11 mm
MEAN ± S.D				1.11 ± 1.364

Table 4

Patient	N-Pg			
	Pre Op	**Immediate Post Op**	**6 Months Post Op**	**Difference**
CASE1 28/M	-27mm	-03mm	-06mm	03mm
CASE 2 22/F	-13mm	-09mm	-09mm	00mm
CASE 3 24/M	-05mm	02mm	02mm	00mm
CASE 4 23/F	-08mm	02mm	01mm	01mm
CASE 5 24/F	-22mm	-15mm	-15mm	00mm
CASE 6 17/F	-22mm	-17mm	-22mm	05mm
CASE 7 19/F	-18mm	-12mm	-12mm	00mm
CASE 8 17/F	-15mm	-07mm	-09mm	02mm
CASE 9 23/F	-10mm	03mm	00mm	03mm
MEAN				1.56mm
MEAN ± S.D				1.56 ± 1.589

Table 5

Patient	Go-Pg Linear			
	Pre Op	Immediate Post Op	6 Months Post Op	Difference
CASE1 28/M	85mm	89mm	87mm	02mm
CASE 2 22/F	85mm	90mm	86mm	04mm
CASE 3 24/M	87mm	75mm	72mm	03mm
CASE 4 23/F	75mm	80mm	78mm	02mm
CASE 5 24/F	78mm	81mm	79mm	02mm
CASE 6 17/F	73mm	82mm	76mm	06mm
CASE 7 19/F	76mm	80mm	79mm	01mm
CASE 8 17/F	76mm	79mm	79mm	00mm
CASE 9 23/F	78mm	82mm	81mm	01mm
MEAN				2.33
MEAN ± S.D				2.33 ± 1.802

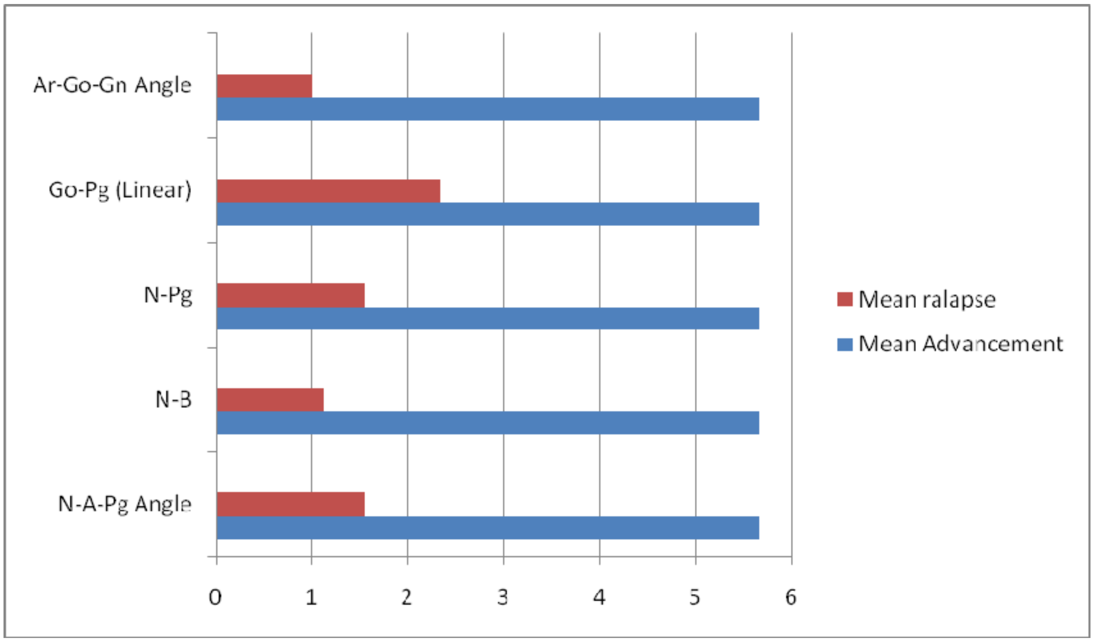
Table 6

Patient	Ar-Go-Gn Angle			
	Pre Op	**Immediate Post Op**	**6 Months Post Op**	**Difference**
CASE1 28/M	128°	132°	131°	01°
CASE 2 22/F	131°	134°	133°	01°
CASE 3 24/M	130°	134°	133°	01°
CASE 4 23/F	141°	135°	134°	01°
CASE 5 24/F	127°	123°	123°	00°
CASE 6 17/F	125°	129°	128°	01°
CASE 7 19/F	127°	130°	129°	01°
CASE 8 17/F	131°	133°	132°	01°
CASE 9 23/F	122°	126°	124°	02°
MEAN				01°
MEAN ± S.D				1 ± 0.5

Table 7

Patient	Pre – Op	Post – Op	Surgical Advancement	6 months relapse				
				N-A-Pg Angle	N-B	N-pg	Go-Pg (Linear)	Ar-Go-Gn Angle
CASE1 28/M	01/10/98	09/05/01	06 mm	04°	00mm	03mm	02mm	01°
CASE 2 22/F	03/06/05	20/02/06	05 mm	02°	02mm	00mm	04mm	01°
CASE 3 24/M	09/05/05	06/02/06	06 mm	04°	01mm	00mm	03mm	01°
CASE 4 23/F	03/07/05	26/06/06	07 mm	00°	01mm	01mm	02mm	01°
CASE 5 24/F	19/07/05	27/06/08	05 mm	00°	02mm	00mm	02mm	00°
CASE 6 17/F	14/05/07	31/01/09	06 mm	02°	00mm	05mm	06mm	01°
CASE 7 19/F	11/01/08	24/01/09	05 mm	01°	04mm	00mm	01mm	01°
CASE 8 17/F	23/12/08	12/09/09	05 mm	01°	00mm	02mm	00mm	01°
CASE 9 23/F	20/03/09	17/12/09	06 mm	00°	00mm	03mm	01mm	02°
MEAN			5.67mm	1.56 °	1.11 mm	1.56mm	2.33 mm	01°
MEAN ± SD				1.56° ± 1.589	1.11mm ± 1.36	1.56mm ± 1.589	2.33 mm ± 1.802	1°± 0.5

Chart I – HORIZONTAL RELAPSE FOLLOWING MANDIBULAR ADVANCEMENT



DISCUSSION

Orthognathic surgery as a modality of treatment for dentofacial deformities and has been gaining importance over the last few decades. Bilateral sagittal split ramus osteotomies are being used as a modality of treatment in India for the past 3-4 decades. Relapse following orthognathic surgery is a major hurdle yet to be overcome by the surgeons.

Relapse has been associated with the type of the movement that is being done during the procedure. Superior positioning of the maxilla is the most stable orthognathic procedure, closely followed by mandibular advancement in patients with short or normal facial height and less than 10 mm advancement and then follows double jaw procedures[29], correction of asymmetry, mandibular setback and down grafting of the maxilla.

Relapse has also been attributed to the type of fixation done during the procedure with more rigid fixation scoring over the wire fixation techniques [18,19]. The magnitude of the movement also contributes to the relapse with the anterior repositioning causing more relapse than the posterior repositioning procedures and has been attributed to the increased muscle activity[14].

Relapse increase when the patient has been treated before the cessation of the growth making the timing of the orthognathic procedures as important factor in the management of dentofacial deformities[20].

Certain factors such as post surgical splints, placing the patients in maxillomandibular fixation, pre and post surgical orthodontics have been advocated to reduce the incidence of relapse.

In previous studies, the relapse after rigid fixation with screws and miniplates after mandibular advancement varied from 5.2% to 26%. In some studies direction of the net relapse was backwards, in others forwards. Kirkpatrick et al. observed an average relapse of 8% after 6 months measured at the B point[33]. Van Sickels and Flanary, Witnessed slight initial relapse, followed by continued anterior movement[10]. An average anterior movement of 19% at B point and 36% at the pogonion point was measured. Relapse was seen to increase with the advancement greater than 6-7 mm measured at the B point and pogonion.

In our series of cases which were treated with pre-surgical orthodontics, mandibular advancement by sagittal split ramus osteotomy and post surgical orthodontics, horizontally we experienced a mean relapse of 1.11mm at B point and 1.56mm at Pg after mandibular advancement during post operative follow up period.

Kohn et al. using wire osteosynthesis, reported superior movement of the proximal segment during fixation and increase in the gonial and mandibular plane angles. In our study, the miniplate fixation was very stable with regard to the position of the proximal fragment. The mean decrease of 1° in the gonial angle was seen during follow up period. All the results obtained in the study are within the range mentioned in the literature.

The use of miniplates to obtain internal fixation has advantages over the maxillomandibular fixation methods because relapse is much less. The relapse rate is also comparable to that occurring with Bicortical screw osteosynthesis.

When condylar repositioning is necessary, this method has the advantage that only one screw needs to be adjusted at each side. In our study because the mean magnitude of lengthening was 5.67 mm, the results with larger advancements need to be studied.

SIMMONS et al. found a relapse of 7% after mandibular advancement with wire fixation after 1 year. BOUWMAN et al. showed a relapse of 3% after mandibular advancement with wire fixation[19,15] after 1 year.

Results of our study and these two studies suggest that the process of skeletal relapse most probably continues over a longer period than the usual follow-up time of most studies.

Skeletal relapse which is measurable at the skeletal chin (B-point and pogonion), is a complex multifactorial phenomenon and can occur through three different mechanisms illustrated in the introduction. Cephalometrically, positional change of gonion and ramus inclination are most indicative for the rotation of the ramus segment with condylar displacement[17,20]. The extent of the osteotomy slippage is measured as a change in mandibular corpus length.

The morphological condylar changes, such as remodeling and resorption, used to be associated with a decrease in length of the mandibular ramus.

In this study, we observed a positional change of gonion in an inferior direction at the immediate postoperative stage, which indicates the dislocation of the proximal segment downwards. Both gonion and the proximal segment returned to their individual preoperative position in the early postoperative period of 6 months. At the same time, both B-point and pogonion advanced slightly further.

This result suggests that not only inferior but also posterior dislocation of the condyles occurred as a result of the surgery, which postoperatively caused an additional forward movement of the mandible. This phenomenon, which has also been observed by others is considered advantageous in some cases of mandibular advancement, because the resulting postoperative additional mandibular advancement might compensate for postoperative short-term skeletal relapse.

Previous studies have reported a counterclockwise[17] rotation of the proximal segment after mandibular advancement. Some studies suggested that the counterclockwise rotation may contribute to skeletal relapse. MOBARAK et al. Suggested that counterclockwise rotation of the ramus leads to instability because the altered muscle orientation following this movement tends to return the proximal segment to its original inclination, which results in a posterior movement of the chin.

KERSTENS et al[20]. stated that counterclockwise rotation leads to compression of the more anterior part of the articular surface of the condyle, which results in progressive condylar resorption. In our study, a counterclockwise rotation of the proximal segment during surgery was also observed.

Over the long term, therefore, the counterclockwise rotation of the proximal segment seems to have no significant influence on skeletal relapse. Intersegmental movement at the osteotomy site (osteotomy slippage) has been reported to occur at the early postoperative stage before bony union has been established.

In several studies, osteotomy slippage was considered one of the main reasons for the early skeletal relapse which occurred during the first 6 weeks to 2 months postoperatively. MOBARAK et al. reported that the osteotomy slippage was observable in particular in low-angle patients. GASSMANN et al. explained the occurrence of the osteotomy slippage by the decreased contact surface of bone fragments, emphasizing that especially large advancements produce smaller interfaces of bone at the osteotomy site. Thus, a large surgical movement may predispose to this type of relapse.

Compared to other studies, the mean amount of surgical advancements performed in our study was relatively small, as shown in. This may be a reason why the osteotomy slippage was not seen in our study and was not observable in our low-angle patients. Several radiological studies reported that the first signs of condylar resorption[20,25] were apparent from 6 months or more after mandibular advancement. However, there is still controversy about the duration of the condylar resorption process.

Most studies describe progressive condylar resorption up to 2 years postoperatively, with incidence of 1% to 7% of the patients. As far as we know, the study by HOPPENREIJS[15] et al. has the longest follow-up of condylar resorption after mandibular advancement reported in the literature. Six years postoperatively, they found an incidence of 23.6% of condylar resorption. In our study, morphological condylar changes were not examined radiologically. However, the decrease of the ramus length, which is indicative of progressive condylar resorption.

Even though progressive condylar resorption is most likely the main reason for late and long-term skeletal relapse, there was a clear difference in occurrence of relapse between our high- and low-angle patients.

Our result suggests that perhaps high-angle patients are not specifically predisposed to progressive condylar resorption[20,25] and to the resulting skeletal relapse. It is possible that resorptive condylar changes may occur during long term. But the morphological condylar changes become visible in the form of skeletal relapse predominantly in high-angle patients.

Many studies have identified the magnitude of advancement as the major factor contributing to skeletal relapse. It has been stated by the majority that large advancement tends to generate comparatively larger and more prolonged soft-tissue tensile forces. These forces presumably lead to joint remodeling with progressive condylar resorption[2,3].

On the other hand, HWANG et al[17] reported that the magnitude of mandibular advancement had no effect on the incidence of postoperative condylar resorption. They observed that condylar resorption occurred on the anterior-superior surface of the condyle and not on the posterior surface where posterior forces lead to compression. In our study also, only a weak correlation between the magnitude of the mandibular advancement and that of the subsequent skeletal relapse was found.

The correlation of the initial surgical movement to the decrease in ramus length was also weak. At least within the range of surgical movements performed in our study, our results contradict the general statement that the amount of initial surgical advancement closely relates to skeletal relapse.

The total relapse at B-point and pogonion was a continuous process over the long-time period and accounted for approximately 50% of surgical advancement 12 years after the initial operation in the study conducted by N. EGGENSPERGER et al. Neither counterclockwise rotation of the proximal segment caused by the surgery nor osteotomy slippage was significantly related to early skeletal relapse.

Surgical displacement of the condyle in an inferior and posterior direction may rather compensate for early skeletal relapse. Progressive condylar resorption seems to be most responsible for long-term skeletal relapse.

SUMMARY AND CONCLUSION

This is a retrospective study in which lateral cephalometric radiograph were evaluated by Burstone Hard tissue analysis to calculate the short term relapse after six months of the advancement bilateral sagittal split ramus osteotomy. Nine patients were included in the study.

Comparing serial standardized lateral cephalograms taken preoperatively, immediate and 6 months postoperatively, the assessment of changes in repositioned mandible in horizontal and vertical plane was made.

Important observation and findings in this study:

The mean horizontal mandibular movement was 5.67 mm and the calculated mean relapse was 1.11mm at B point and 1.56mm at Pg point during follow up period of six months.

The mean calculated relapse at N-A-Pg was 1.56mm ,the mean calculated relapse at Go-Pg was 2.33 mm, and the mean relapse of Ar-Go-Gn Angle with a mean relapse of 01°.

In our study various factors like adequate stripping or release of pterygo massetric sling, adequate mobilization of proximal and distal segments, passive condylar positioning, achieving maximum *intercuspation* at the end of surgery using planned pre-surgical orthodontics are considered for more stability.

Considering these factors it can be concluded from the data presented that stabilization of the fragments after advancement BSSRO by miniplates generally leads to predictable and stable results and all the results obtained here are within the range of values mentioned in the literature. However, a well randomized prospective case control study with a longer follow up is needed for better knowledge.

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